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Research Article

Prevalence, Antimicrobial Resistance Patterns, and Risk Factors of Methicillin-resistant Staphylococcus Aureus in Wound Infections at Two Hospitals in Sidama, Ethiopia

Asegid Regas Tabour[1, *], Tenaye Zemede[2, †], Busera Seman[3, †]

[1]Wonsho Woreda Health Office, Hawassa, Ethiopia

[2]College of Medicine and Health Sciences, Hawassa University, Hawassa, Ethiopia

[3]Hawassa College of Health Sciences, Hawassa, Ethiopia

Abstract

Background: Methicillin-resistant Staphylococcus aureus (MRSA) is a drug-resistant bacteria that causes serious infections and withstands common antibiotics. It spreads in both hospitals and communities, making it a persistent and dangerous global health threat. Data on its prevalence and drivers in wound infections in Ethiopia, specially in the Sidama region, is limited. This study aimed to determine the prevalence, antimicrobial susceptibility pattern, and risk factors of MRSA isolated from wound infections. *Methods:* A hospital-based cross-sectional study was conducted at Hawassa Referral and Adare General Hospitals from June to July 2024. A total of 246 participants with wound infections were enrolled using a consecutive sampling technique. Wound swabs were collected and processed for S. aureus following standard microbiological procedures. MRSA was detected using cefoxitin disk diffusion. Data on sociodemographic and clinical variables were collected and analyzed using logistic regression to identify factors associated with MRSA. *Results:* Out of 246 participants, 76 (30.9%) were positive for S. aureus. The overall prevalence of MRSA was 4.9% (12/246). All MRSA isolates were susceptible to vancomycin and linezolid but showed high resistance to penicillin (100%), clindamycin (66.7%), and erythromycin (50.0%). In the multivariable analysis, male gender (AOR = 1.94, 95% CI: 1.08–3.46), age 31–45 years (AOR = 31.67, 95% CI: 3.26–307.16), rural residence (AOR = 9.11, 95% CI: 1.16–71.70), and deep wound infection (AOR = 28.53, 95% CI: 3.47–234.81) were identified as independent predictors of MRSA. *Conclusions:* This study reveals a notable prevalence of MRSA in wound infections, with several modifiable risk factors. These findings underscore the urgent need for reinforced infection prevention and control strategies, including targeted antimicrobial stewardship and robust surveillance systems, to curb the spread of MRSA in our healthcare settings.

Keywords

MRSA, Wound Infection, Antimicrobial Resistance, Risk Factors, Ethiopia, Infection Control

*Correspondence: Asegid Regas Tabour (asegidregas79@gmail.com)

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1. Background

Staphylococcus aureus is a leading cause of both community and healthcare-associated bacterial infections worldwide, with wound infections representing a common and serious clinical manifestation [1]. The emergence and global dissemination of methicillin-resistant S. aureus (MRSA) have severely compromised the efficacy of standard beta-lactam antibiotics, leading to complex treatment challenges, prolonged hospitalization, increased healthcare costs, and higher mortality rates [2, 3].

The burden of antimicrobial resistance (AMR) is disproportionately high in low- and middle-income countries. A landmark 2019 study on the global burden of AMR attributed 4.95 million deaths to bacterial AMR, with sub-Saharan Africa bearing the highest burden [4]. In Ethiopia, although several studies have reported on MRSA, the prevalence rates vary widely across different regions and healthcare facilities, highlighting the necessity for localized surveillance data [5, 6]. Vancomycin remains a cornerstone for treating severe MRSA infections; however, the emergence of vancomycin-resistant S. aureus (VRSA) poses a catastrophic threat, underscoring the need for continuous monitoring [7].

Wound infections provide an ideal environment for S. aureus colonization and subsequent disease. Effective infection control and empirical therapy rely heavily on current, local data regarding the prevalence of MRSA and its associated risk factors. Such information is crucial for developing context-specific interventions but remains scarce for the Sidama region of Ethiopia. Therefore, this study was conducted to determine the prevalence of MRSA and VRSA, and to identify the associated risk factors among patients with wound infections at Hawassa Referral and Adare General Hospitals.

2. Methods

2.1. Study Design, Setting, and Period

A hospital-based cross-sectional study was conducted at Hawassa Referral and Adare General Hospitals in Hawassa City, Sidama Region, Ethiopia, from June 1 to July 30, 2024. These hospitals serve as primary referral centers for the Sidama region and neighboring areas.

2.2. Study Participants and Sampling

The source population consisted of all patients presenting with wound infections at the surgical, orthopedic, emergency, and other relevant wards. Patients who had received systemic or topical antibiotic therapy within two weeks prior to sample collection were excluded, as were those unable to provide informed consent. The sample size of 246 was calculated using a single population proportion formula, assuming a 82.3% prevalence of MRSA from a previous study in Ethiopia [8], a 95% confidence level, and a 5% margin of error. Participants were enrolled using a consecutive sampling technique until the required sample size was achieved.

2.3. Data Collection and Laboratory Processing

Sociodemographic and clinical data were collected through face-to-face interviews using a structured and pre-tested questionnaire. Wound swab samples were collected aseptically by trained nurses from the wound bed after cleansing with sterile normal saline. Specimens were transported in Amies transport medium to the microbiology laboratory at Yirgalem Hospital Medical College for processing within 2 hours of collection.

Specimens were inoculated onto Mannitol Salt Agar (MSA) and 5% Sheep Blood Agar and incubated aerobically at 37℃ for 24–48 hours. Presumptive S. aureus colonies (mannitol fermentation on MSA, beta-hemolysis on Blood Agar) were subcultured to obtain pure isolates. Identification was confirmed by standard methods: Gram stain (Gram-positive cocci in clusters), a positive catalase test, and a positive tube coagulase test.

Antimicrobial susceptibility testing (AST) was performed on Mueller-Hinton Agar using the Kirby-Bauer disk diffusion method, and results were interpreted according to CLSI 2020 guidelines [9]. The antibiotics tested included: Cefoxitin (30 µg), Clindamycin (2 µg), Erythromycin (15 µg), Linezolid (30 µg), Penicillin (10 units), and Vancomycin (30 µg). MRSA was identified using a cefoxitin disk (zone diameter ≤21 mm). S. aureus ATCC® 25923 was used for quality control throughout the AST process.

2.4. Data Analysis

Data were entered into Epi-Data version 4.6 and exported to SPSS version 25 (IBM Corp., Armonk, NY, USA) for analysis. Descriptive statistics (frequencies, percentages) were computed. Binary logistic regression was used to assess crude associations between independent variables and MRSA status. Variables with a p-value < 0.25 in the bivariate analysis were included in a multivariable logistic regression model to control for potential confounders and identify independent predictors. An Adjusted Odds Ratio (AOR) with a 95% Confidence Interval (CI) was reported, and a p-value < 0.05 was considered statistically significant. The model's goodness-of-fit was assessed using the Hosmer-Lemeshow test.

2.5. Ethical Consideration

Ethical approval was obtained from the Institutional Review Board (IRB) of Yirgalem Hospital Medical College. Written permission was secured from the administrative bodies of both hospitals. Written informed consent was obtained from all participants after explaining the purpose, procedures, potential benefits, and risks of the study. For participants under the age of 18, assent was obtained from the child and written informed consent from their parent or guardian. All information obtained from the participants was kept confidential using code numbers instead of personal identifiers.

3. Results

3.1. Sociodemographic and Clinical Characteristics

A total of 246 participants were enrolled, yielding a response rate of 100%. The sociodemographic and clinical characteristics are summarized in Table 1. The majority of participants were male (60.6%), within the age group of 31–45 years (39.8%), and resided in rural areas (56.9%). Most wounds were classified as deep (76.8%), and a significant proportion of participants (76.8%) reported using antibiotics in the 12 months preceding the study.

***Table 1.** Sociodemographic and clinical characteristics of study participants (N=246).*

Variable	Category	Frequency (n)	Percentage (%)
Age Group (years)	<15	41	16.7
	15-30	94	38.2
	31-45	98	39.8
	46-60	9	3.7
	>60	4	1.6
Gender	Male	149	60.6
	Female	97	39.4
Educational Status	Not educated	20	8.1
	Primary (1-8)	68	27.6
	Secondary (9-12)	76	30.9
	College (10+ or 12+)	63	25.6
	Other	19	7.7
Place of Residence	Urban	107	43.5
	Rural	139	56.5
Wound Depth	Superficial	57	23.2
	Deep	189	76.8
Antibiotic Use (last 12 months)	Yes	189	76.8
	No	57	23.2

3.2. Prevalence of S. Aureus and MRSA

Out of the 246 wound swabs processed, 76 were positive for S. aureus, yielding a prevalence of 30.9%. Among these S. aureus isolates, 12 were confirmed as MRSA. The overall prevalence of MRSA among the study participants was 4.9% (12/246). Among the S. aureus isolates, the proportion of MRSA was 15.8% (12/76). No vancomycin-resistant S. aureus (VRSA) was identified.

3.3. Antimicrobial Susceptibility Pattern

The overall S. aureus isolates showed high susceptibility to vancomycin (100%), linezolid (100%), and tigecycline (100%). In contrast, high resistance was observed to penicillin (98.7%) and erythromycin (75.0%). All 12 MRSA isolates were resistant to cefoxitin and penicillin (100%). A high level of resistance was also observed to clindamycin (66.7%) and erythromycin (50.0%) among MRSA isolates.

3.4. Factors Associated with MRSA Infection

In the bivariate analysis, variables such as gender, age, residence, history of wound infection, completion of antibiotic dosage, wound depth, and ward of admission met the threshold ($p < 0.25$) for inclusion in the multivariable model. After adjusting for potential confounders, four factors remained independently associated with a higher odds of MRSA infection (Table 2). The odds of MRSA were significantly higher in males (AOR = 1.94, 95% CI: 1.08–3.46), participants aged 31–45 years (AOR = 31.67, 95% CI: 3.26–307.16), rural residents (AOR = 9.11, 95% CI: 1.16–71.70), and those with deep wound infections (AOR = 28.53, 95% CI: 3.47–234.81).

Table 2. *Bivariate and multivariable analysis of factors associated with MRSA among patients with wound infection (N=246).*

Variable	Category	COR (95% CI)	p-value	AOR (95% CI)	p-value
Gender	Male	0.13 (0.02 - 1.05)	0.055	1.94 (1.08 - 3.46)	0.026
	Female*	Ref		Ref	
Age Group (years)	<15*	Ref		Ref	
	15-30	40.0 (2.46 - 650.64)	0.010	40.0 (0.01 - 4.75)	0.322
	31-45	31.7 (3.27 - 307.16)	0.003	31.67 (3.26 - 307.16)	0.003
	46-60	17.8 (2.06 - 153.89)	0.009	17.80 (0.01 - 21.0)	0.625
	>60	8.0 (0.46 - 139.29)	0.154	8.0 (0.002 - 8.095)	0.316
Place of Residence	Rural	9.12 (1.16 - 71.70)	0.036	9.11 (1.16 - 71.70)	0.036
	Urban*	Ref		Ref	
Wound Depth	Deep	22.21 (4.70 - 105.04)	<0.001	28.53 (3.47 - 234.81)	0.002
	Superficial*	Ref		Ref	

*Reference category; COR: Crude Odds Ratio; AOR: Adjusted Odds Ratio; CI: Confidence Interval

4. Discussion

This study investigated the prevalence and risk factors of MRSA in wound infections at two hospitals in Sidama, Ethiopia. The overall prevalence of MRSA was 4.9%, which is lower than some that reports from Ethiopia [8, 15, 16] but aligns with studies from other parts of East Africa, such as Kenya (5.5%) and Tanzania (3.5%) [10, 11]. These geographical and temporal variations in MRSA prevalence highlight the dynamic nature of antimicrobial resistance and reinforce the critical importance of continuous local surveillance to guide empirical therapy and infection control policies.

The multivariable analysis revealed several independent risk factors for MRSA infection. The exceptionally strong association between deep wounds and MRSA (AOR=28.53) is a particularly salient finding. Deep wounds often necessitate longer hospital stays, more frequent dressing changes, and invasive procedures like debridement, all of which increase opportunities for exposure to healthcare-associated pathogens [12]. Furthermore, the compromised vascularity and potential for biofilm formation in deep tissues can shield bacteria from host defenses and antimicrobial agents, creating a niche for resistant organisms to thrive [13].

The significantly higher odds of MRSA among rural residents (AOR=9.11) suggest potential disparities in healthcare access and antibiotic usage patterns. Patients from rural areas might experience delays in seeking formal medical care, leading to more advanced infections upon presentation. They may also have greater reliance on non-prescription antibiotics or use incomplete courses of medication, practices known to drive the selection and spread of resistant bacteria [14]. The association with male gender has been documented in other settings and could be related to occupational hazards, risk-taking behaviors, or differences in health-seeking practices [5].

The antimicrobial susceptibility profile reveals a concerning level of resistance to commonly used antibiotics like penicillin, clindamycin, and erythromycin among MRSA isolates, rendering them poor choices for empirical treatment. The preserved and universal susceptibility to vancomycin and linezolid is consistent with global reports and confirms their status as last-line agents. This finding underscores the paramount importance of implementing and enforcing antimicrobial stewardship programs to preserve the efficacy of these critical drugs.

5. Limitations

This study has several limitations. Its cross-sectional design precludes the determination of causal relationships between the identified risk factors and MRSA infection. The use of a consecutive sampling technique, though practical, may limit the generalizability of the findings to other patient populations or healthcare settings. The study was conducted in only two hospitals over a relatively short period, which may not capture seasonal variations in MRSA prevalence. Finally, the absence of molecular characterization of the MRSA strains means we cannot comment on their clonal relatedness or the specific genetic determinants of resistance, which would be valuable information for understanding transmission dynamics.

6. Conclusions

In conclusion, this study documents a considerable prevalence of MRSA in wound infections within the study setting. The identification of male gender, middle age, rural residence, and deep wounds as key risk factors provides a clear target for intervention. The high level of resistance to first-line antibiotics underscores the therapeutic challenges faced by clinicians.

7. Recommendations

Based on our findings, we recommend the following:

1) Enhanced Infection Prevention and Control (IPC): Strengthen IPC measures with a particular focus on aseptic wound care practices and contact precautions for patients with deep wounds.
2) Targeted Antimicrobial Stewardship (AMS): Implement AMS programs to promote the rational use of antibiotics, especially vancomycin, based on local susceptibility data to prevent further emergence of resistance.
3) Robust Surveillance: Establish a continuous, laboratory-based surveillance system for MRSA and other antimicrobial-resistant pathogens to monitor trends and inform national treatment guidelines.
4) Community Health Education: Intensify public health education in rural communities on the importance of completing prescribed antibiotic courses, the dangers of self-medication, and the need for timely presentation of wounds for professional care.

Abbreviations

AMR	Antimicrobial Resistance
AOR	Adjusted Odds Ratio
AST	Antimicrobial Susceptibility Testing
CI	Confidence Interval
CLSI	Clinical and Laboratory Standards Institute
COR	Crude Odds Ratio
IPC	Infection Prevention and Control
MRSA	Methicillin-Resistant Staphylococcus Aureus
VRSA	Vancomycin-Resistant Staphylococcus Aureus

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Author Contributions

Asegid Regas Tabour: Conceptualization, Methodology, Formal Analysis & Investigation, Data Curation, Software, Writing – original draft, Writing – review & editing

Tenaye Zemede: Methodology, Formal Analysis & Investigation

Busera Seman: Methodology, Formal Analysis & Investigation

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Data Availability Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable require.

Conflicts of Interest

The authors declare no conflicts of interest related to this research. The study was conducted independently, without commercial, financial, or political influence.

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